ORIGINAL RESEARCH

Trends in the Ambulatory Management of Headache: Analysis of NAMCS and NHAMCS Data 1999–2010

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BACKGROUND: Headache is a frequent complaint and among the most common reasons for visiting a physician.

OBJECTIVE: To characterize trends from 1999 through 2010 in the management of headache.

DESIGN: Longitudinal trends analysis.

DATA: Nationally representative sample of visits to clinicians for headache from the National Ambulatory Medical Care Survey and National Hospital Ambulatory Medical Care Survey, excluding visits with “red flags,” such as neurologic deficit, cancer, or trauma.

MAIN MEASURES: Use of advanced imaging (CT/MRI), opioids/barbiturates, and referrals to other physicians (guideline-discordant indicators), as well as counseling on lifestyle modifications and use of preventive medications including verapamil, topiramate, amitriptyline, or propranolol (guideline-concordant during study period). We analyzed results using logistic regression, adjusting for patient and clinician characteristics, and weighted to reflect U.S. population estimates. Additionally, we stratified findings based on migraine versus non-migraine, acute versus chronic symptoms, and whether the clinician self-identified as the primary care physician.

KEY RESULTS: We identified 9,362 visits for headache, representing an estimated 144 million visits during the study period. Nearly three-quarters of patients were female, and the mean age was approximately 46 years. Use of CT/MRI rose from 6.7 % of visits in 1999–2000 to 13.9 % in 2009–2010 (unadjusted $p < 0.001$), and referrals to other physicians increased from 6.9 % to 13.2 % ($p = 0.005$). In contrast, clinician counseling declined from 23.5 % to 18.5 % ($p = 0.041$). Use of preventive medications increased from 8.5 % to 15.9 % ($p = 0.001$), while opioids/barbiturates remained unchanged, at approximately 18 %. Adjusted trends were similar, as were results after stratifying by migraine versus non-migraine and acute versus chronic presentation. Primary care clinicians had lower odds of ordering CT/MRI (OR 0.56 [0.42, 0.74]).

CONCLUSIONS: Contrary to numerous guidelines, clinicians are increasingly ordering advanced imaging and

referring to other physicians, and less frequently offering lifestyle counseling to their patients. The management of headache represents an important opportunity to improve the value of U.S. healthcare.

KEY WORDS: Guidelines; Utilization; Ambulatory care; Physician behavior; Primary care.

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Headache is a common disorder, and can substantially influence quality of life and function. The lifetime prevalence of headache exceeds 95 %, and nearly one-quarter of the population suffers from recurrent severe headaches.^{1–3} It is among the most common chronic pain conditions resulting in lost productivity, leading to 5.4 % of the U.S. workforce missing work each year, and is one of the chief causes of disability worldwide.^{4,5}

Headache is among the most frequent reasons for visiting a physician, accounting for 12 million visits per year in the U.S., and costing upwards of \$31 billion per year.^{5–7} Most cases of headache presenting to clinicians are either acute presentations of a known chronic clinical condition or an acute self-limiting condition. Thus, the assessment of headache depends on identifying the relatively rare instances when serious underlying causes are suspected, which frequently require further investigation. Evidence-based guidelines for primary headache suggest conservative treatments such as counseling on stress reduction or avoiding dietary triggers, and reserve imaging or specialty referrals for circumstances such as neurologic deficits, cancer, trauma, human immunodeficiency virus (HIV), or other “red flags”.^{8–10} The Choosing Wisely campaign of the American Board of Internal Medicine has recently identified reducing the use of advanced imaging and prescriptions for opioids and barbiturates for headache as important opportunities to improve value in our healthcare system.^{11–13}

Despite broad agreement on these issues over the past decade, preliminary evidence suggests persistent overuse of these low-value services.^{14,15} In this context, we used

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nationally representative data on ambulatory visits to clinicians to evaluate trends over the past decade in headache management in the office setting.

METHODS

We used nationally representative data on visits to clinicians from the National Ambulatory Medical Care Survey (NAMCS) and the National Hospital Ambulatory Medical Care Survey (NHAMCS) during the period January 1, 1999, through December 31, 2010.¹⁶ The NAMCS represents a probability sample of ambulatory visits to non-federal office-based practices, and the NHAMCS comprises ambulatory visits to non-federal hospital-based outpatient departments, including ambulatory clinics and emergency departments. Designed in parallel, the NAMCS and NHAMCS share a common design, survey variables, and visit weights, and when combined, are reflective of ambulatory visits nationally.^{17,18} Further details are available from the National Center for Health Statistics.

Data Collection Procedures

Both the NAMCS and NHAMCS use a multi-stage probability sample design to obtain nationally representative samples of ambulatory patient visits in the United States.¹⁹ In the first stage of sampling, 112 primary geographic sampling units were selected from among those used in the National Health Interview Survey. For the second stage, clinician practices or hospitals were chosen within these primary sampling units. Finally, in the last stage, visits were sampled over a predefined time period. This design enabled calculation of national-level estimates and associated standard errors using survey weights provided by the National Center for Health Statistics.

The data were obtained using a standardized survey form that the clinician or other staff completed soon after each patient visit. Both the NAMCS and NHAMCS collect data on the patient's primary reason for visit (e.g., chief complaint), two other non-primary reasons for visit, up to three diagnoses derived from the *International Classification of Diseases, Clinical Modification, Ninth Revision (ICD-9-CM)*, the expected payer for the visit (e.g., Medicaid, private insurance), patient and clinician characteristics, diagnostic tests and treatments ordered, and medications listed during the visit.

Study Sample

We identified ambulatory visits (excluding emergency department visits) with a chief complaint and/or a primary diagnosis of headache. We also included those with secondary complaints and diagnoses of headache, but unrelated primary reasons for the visit (e.g., hyperlipidemia). We used reason-

for-visit codes to capture all headache- and migraine-related complaints, and ICD-9-CM codes to capture all migraine- and headache-related diagnoses.

In the subset of patient visits with a chief complaint of headache (80.8 % of visits in the sample), the NAMCS and NHAMCS provide duration or context of symptoms in five categories: (1) new onset (less than three months' duration), (2) acute on chronic flare-up, (3) chronic routine (4) routine/preventive, and (5) pre- or postoperative visit. Symptom context was missing 1.7 % of the time. We defined 'acute' visits by combining new-onset symptoms and acute on chronic symptoms. We then compared visits for the 'acute' group' with the remaining visits.

We excluded visits with concomitant red-flag reasons for visit or diagnoses, including fever, neurologic signs or symptoms (including altered level of consciousness), cancer, head trauma, fracture of the skull or face, pregnancy and associated complications, HIV, epilepsy/seizures, or papilledema, that might indicate something other than uncomplicated headache.⁸⁻¹⁰ See the Section on Sample Selection and Tables A1, A2, and A3 in the Appendix (available online) for details on cohort design as well as inclusion and exclusion criteria.

Main Outcomes Measures

We studied four types of measures: 1) use of advanced imaging, including both computed tomography (CT) and magnetic resonance imaging (MRI) (see [Online Appendix for details](#)); 2) referrals to other physicians; 3) clinician counseling on lifestyle modifications during headache visits, including dietary and nutrition education/counseling, exercise education/counseling, stress management and mental health education/counseling (given dietary, lifestyle, and psychosocial influences on migraine and tension-type headaches as well as clinical guideline recommendations);⁸⁻¹⁰ and 4) use of medications including non-steroidal anti-inflammatory drugs (NSAIDs, including COX-2 inhibitors), acetaminophen (including both prescription and over-the-counter NSAIDs and acetaminophen), preventive therapies (verapamil, amitriptyline, topiramate, or propranolol), abortive therapies such as triptans or ergot alkaloids, and therapies whose use is discouraged, such as opioids or barbiturates. Before 2003, the NAMCS and NHAMCS collected data on up to only six drugs; therefore, in order to maintain consistency over time, we limited analysis of all years to the first six drugs listed. We selected these outcomes based on the recommendations contained in three major clinical guidelines that would most likely influence clinician behavior during the study period.⁸⁻¹⁰ For more details on the identification of relevant guidelines, please see the [Online Appendix](#).

Stratified and Sensitivity Analyses

Because migraine and other types of primary headaches (predominantly tension headache) have some differences in management, we stratified our analyses by visits with migraine versus those without. In order to evaluate the extent to which symptom duration affected our results, we also examined the subset of visits with a chief complaint of headache, after stratifying by acute versus chronic presentations as defined above. Additionally, we stratified our analyses based on whether the clinician self-identified as the patient's PCP, which was determined by whether she answered "Yes" to the survey question: "Are you the patient's primary care physician?"

We also performed two sensitivity analyses in order to ensure that our outcomes were linked to headache and not some other condition. First, we restricted our analyses to those patients with a chief complaint of acute or new-onset (less than three months' duration) headache as our gold-standard group. Results for this subgroup were similar to the overall findings, further validating the trends of the entire cohort. Second, although we lacked complete data on the duration of symptoms, we present results stratified by acute versus chronic presentations, which revealed similar trends. Additionally, we excluded patients with potentially competing co-diagnoses commonly associated with imaging, referrals, counseling, or opioids (e.g., back pain, abdominal pain, joint pains, etc.). When we removed visits with these competing diagnoses, overall trends remained unchanged; therefore, we included these visits in order to maximize power (for details, see Online Appendix for Competing Diagnoses Section and Table A5).

Statistical Analysis

We evaluated unadjusted trends using bivariable logistic regression and examined categorical variables using χ^2 tests. For each outcome measure, we present proportions of utilization for each time interval after pooling the survey data into six two-year intervals, based on recommendations from the National Center for Health Statistics. For the adjusted and stratified analyses, we used logistic regression models for each outcome, focusing on a linear trend for each two-year interval, and adjusting for age, gender, race/ethnicity, insurance status, whether the clinician was the PCP, urban location, geographic region, and the duration of symptoms (available among 80.8 % of our sample). Race/ethnicity was defined by the healthcare professionals completing the survey. We categorized race as white, black, or other. We then re-categorized patients of any race who were also identified as Hispanic in order to construct a single four-level race/ethnicity variable. Finally, we used logistic regression pooled across the entire sample to evaluate factors independently associated with ordering advanced diagnostic imaging, referring to another

physician, or offering lifestyle modification counseling during headache visits.

All analyses were performed using SAS-callable SUDAAN version 10.0 (RTI International, Research Triangle Park, NC, USA), using SUDAAN subpopulation procedures, which used information from the entire NAMCS/NHAMCS sample to account for the complex study design and sampling weights to produce national estimates, while not considering observations from emergency departments in computing these estimates.¹⁷ The Harvard Medical School Committee on Human Studies determined that this study was exempt from review.

RESULTS

We studied 9,362 visits related to headache, which represented an estimated 144 million visits during the study period, or a

Table 1. Patient and Visit Characteristics over Time (% of Visits)

Year (sample <i>n</i>)	1999– 2000 (<i>n</i> =1,299)	2009–2010 (<i>n</i> =1,579)	Total	
(<i>n</i> =9,362)	<i>P</i> value			
Age (mean)	46.5	46.8	45.8	0.41
Female sex	75.3	75.2	74.8	0.38
Race/ ethnicity*				0.027
White	71.7	76.0	74.7	
Black	9.8	12.0	11.1	
Hispanic	9.7	7.9	9.7	
Other	5.7	4.1	4.5	
Insurance status				<0.001
Private	57.5	60.4	62.9	
Medicare	13.0	16.8	13.3	
Medicaid	10.3	12.1	10.2	
Workers' comp	2.6	1.4	1.1	
Uninsured	13.4	7.4	9.1	
Identified PCP	57.7	56.1	57.4	0.89
Urban area	79.8	85.2	83.4	0.67
Region				0.45
Northeast	20.7	18.3	18.5	
Midwest	23.2	26.8	23.6	
South	30.7	34.5	36.1	
West	25.4	20.4	21.9	
Nature of headache chief complaints†				<0.001
Acute or new onset	62.3	56.7	55.5	
Chronic routine	32.0	38.9	38.9	
Pre/post-op	2.5	0.60	0.77	
Preventive visit	2.0	3.5	2.4	

PCP primary care physician

*White, black, and other patients are all non-Hispanic. Hispanic origin may include patients of any race. Other race/ethnicity includes persons of Asian, Native Hawaiian, Pacific Islander, American Indian, or multiple races.

†80.8 % of the sample comprises patients with a chief complaint of headache.

Table 2. Unadjusted Use over Time (% of Visits)

Year (sample n)	1999–2000 (n=1,299)	2001–2002 (n=1,717)	2003–2004 (n=1,649)	2005–2006 (n=1,533)	2007–2008 (n=1,579)	2009–2010 (n=1,585)	P value
Advanced imaging (CT/MRI)	6.7	7.1	7.5	9.4	13.5	13.9	<0.001
Referrals to other physicians	6.9	9.5	11.3	10.0	12.9	13.2	0.005
Lifestyle modification counseling	23.5	22.1	22.9	19.7	15.6	18.5	0.041
Medications							
Abortive							
NSAIDs/APAP	15.3	21.5	16.8	14.6	18.1	16.4	0.58
Triptans/ergot	9.8	12.4	13.6	18.6	14.0	15.4	0.022
Preventive	8.5	9.8	10.4	12.9	13.5	15.9	0.001
Opioid/barbiturate	18.6	15.9	19.3	16.7	20.9	18.4	0.67

CT computed tomography, MRI magnetic resonance imaging, NSAIDs non-steroidal anti-inflammatory drugs, APAP acetaminophen, Preventive medications propranolol, verapamil, amitriptyline, and topiramate, Lifestyle modification counseling diet and nutrition education/counseling, exercise education/counseling, stress management/mental health education/counseling

mean of 12.0 million visits per year. Table 1 summarizes trends in patient and visit demographic characteristics (see Table 6 in the Online Appendix for year-by-year trends). Nearly 75 % of patients were female, and the mean age remained stable, at approximately 46 years. The proportion of Medicare recipients increased from 13.0 % in 1999–2000 to 16.8 % in 2009–2010, while the proportion of uninsured patients nearly halved, from 13.4 % to 7.4 %, during the same time period ($p<0.001$).

Unadjusted Trends in Imaging, Referrals, and Counseling

Table 2 summarizes unadjusted trends in use. Advanced imaging, including CT or MRI, increased from 6.7 % of visits in 1999–2000 to 13.9 % in 2009–2010 ($p<0.001$), as did referrals to other physicians, rising from 6.9 % to 13.2 % during the study period ($p=0.005$). In contrast, counseling for headache prevention declined from 23.5 % in 1999–2000 to 18.5 % in 2009–2010 (unadjusted $p=0.041$).

Unadjusted Trends in Medications

The use of NSAIDs and acetaminophen remained stable, at approximately 16 %. Triptans and ergot alkaloids rose from 9.8 % in 1999–2000 to 15.4 % in 2009–2010 ($p=0.022$). Preventive therapies also increased, rising from 8.5 % to 15.9 % during the study period ($p=0.001$). Finally, opioid and barbiturate use remained unchanged, at approximately 18 %.

Adjusted and Stratified Use

After adjustment for age, sex, race/ethnicity, geographic region, insurance status, symptom duration, urban location, and whether the clinician was identified as the PCP, trends in use did not differ substantively from the unadjusted results (Fig. 1).

Comparing visits related to migraine versus non-migraine headache revealed similar trends, albeit with some notable differences (Table 3). Not surprisingly, patients with migraine received triptans/ergot alkaloids and preventive therapies more frequently compared to patients with non-migraine headache.

Figure 1. Adjusted* Lifestyle Counseling, Referrals to Other Physicians, CT/MRI, and Drugs for Headache Over Time. *This figure shows estimates adjusted for age, sex, race/ethnicity, geographic region, urban location, insurance type, symptom duration, and whether the clinician was the PCP. CT computed tomography, MRI magnetic resonance imaging, NSAIDs non-steroidal anti-inflammatory drugs, APAP acetaminophen, Preventive medications propranolol, verapamil, amitriptyline, and topiramate, Lifestyle modification counseling diet and nutrition education/counseling, exercise education/counseling, stress management/mental health education/counseling

Table 3. Adjusted* Proportions of Use by Migraine versus Non-Migraine Headache over Time

Year (sample <i>n</i> , migraine) [sample <i>n</i> , non-migraine]	1999–2000 (<i>n</i> =412) [<i>n</i> =887]	2001–2002 (<i>n</i> =606) [<i>n</i> =1,111]	2003–2004 (<i>n</i> =555) [<i>n</i> =1,094]	2005–2006 (<i>n</i> =609) [<i>n</i> =924]	2007–2008 (<i>n</i> =599) [<i>n</i> =980]	2009–2010 (<i>n</i> =589) [<i>n</i> =996]	<i>P</i> value
Advanced Imaging (CT/MRI)†							
Migraine	5.4	4.6	4.3	4.4	11.7	7.5	0.088
Non-migraine	6.2	7.4	7.6	11.0	12.6	14.8	<0.001
Referrals to other physicians							
Migraine	7.3	5.3	5.4	10.3	12.0	8.5	0.085
Non-migraine	5.9	10.0	12.9	8.4	11.8	14.4	0.004
Lifestyle modification counseling							
Migraine	24.3	17.2	19.3	22.9	16.4	19.0	0.51
Non-migraine	20.9	23.6	22.3	16.4	13.5	16.4	0.002
Medications							
Abortive							
NSAIDs/APAP							
Migraine	7.5	12.7	9.6	12.1	11.2	11.4	0.57
Non-migraine	16.3	23.1	18.7	15.3	19.5	17.9	0.73
Triptans/ergot							
Migraine	28.6	31.5	31.7	35.8	31.0	35.8	0.21
Non-migraine	1.6	4.0	5.3	3.1	3.1	3.0	0.54
Preventive							
Migraine	13.5	16.1	20.3	21.6	23.9	26.5	0.003
Non-migraine	6.1	6.2	5.6	5.0	6.3	8.4	0.24
Opioid/barbiturate							
Migraine	24.9	22.9	33.1	19.3	22.9	20.7	0.50
Non-migraine	14.2	11.8	11.3	13.3	19.1	15.4	0.22

CT computed tomography, MRI magnetic resonance imaging, NSAIDs non-steroidal anti-inflammatory drugs, APAP acetaminophen, Preventive medications propranolol, verapamil, amitriptyline, and topiramate, Lifestyle modification counseling diet and nutrition education/counseling, exercise education/counseling, stress management/mental health education/counseling

*In this table, our models are adjusted for age, sex, race/ethnicity, region, insurance type, symptom duration, whether the healthcare professional was the PCP, and whether the visit was located in a metropolitan area. For this stratified analysis, we collapsed the workers' compensation insurance variable into the uninsured variable due to an insufficient number of cells for the models to converge.

†Test for interaction evaluating for differences in the rate of change between the two subgroups was significant, $p=0.033$.

In addition, opioid or barbiturate use was higher for migraine than non-migraine headaches, although the level of use did not

change over time. Use of CT/MRI rose more rapidly for those with non-migraine headaches ($p=0.033$ for interaction), as did

Table 4. Adjusted* Proportions of Use by Chief Complaint of Acute versus Chronic Headache Over Time

Year (sample <i>n</i> , acute) [sample <i>n</i> , chronic]	1999–2000 (<i>n</i> =686) [<i>n</i> =352]	2001–2002 (<i>n</i> =808) [<i>n</i> =585]	2003–2004 (<i>n</i> =754) [<i>n</i> =577]	2005–2006 (<i>n</i> =672) [<i>n</i> =504]	2007–2008 (<i>n</i> =681) [<i>n</i> =522]	2009–2010 (<i>n</i> =720) [<i>n</i> =594]	<i>P</i> value
Advanced imaging (CT/MRI)							
Acute	9.0	7.1	8.3	8.7	17.8	17.1	<0.001
Chronic	3.3	3.8	3.2	6.3	8.0	5.8	0.030
Referrals to other physicians							
Acute	8.3	8.7	13.5	13.6	14.0	13.7	0.030
Chronic	4.9	8.9	5.8	5.4	10.9	9.0	0.19
Lifestyle modification counseling							
Acute	19.4	21.0	19.2	19.6	15.3	15.5	0.11
Chronic	27.1	21.3	13.8	16.3	14.1	17.6	0.13
Medications							
Abortive							
NSAIDs/APAP							
Acute	15.2	22.0	18.0	17.6	20.0	17.1	0.91
Chronic	13.2	20.9	10.9	8.0	14.2	10.0	0.11
Triptans/ergot							
Acute	9.2	9.1	10.1	13.3	9.7	11.5	0.27
Chronic	10.8	14.4	15.1	15.5	19.5	16.5	0.13
Preventive							
Acute	7.9	5.7	9.4	8.9	6.7	10.6	0.20
Chronic	9.0	14.4	12.8	11.3	21.1	23.0	<0.001
Opioid/barbiturate							
Acute	16.3	13.1	19.0	15.9	18.8	19.4	0.34
Chronic	19.5	16.8	23.3	17.2	19.4	15.7	0.56

CT computed tomography, MRI magnetic resonance imaging, NSAIDs non-steroidal anti-inflammatory drugs, APAP acetaminophen, Preventive medications propranolol, verapamil, amitriptyline, and topiramate, Lifestyle modification counseling diet and nutrition education/counseling, exercise education/counseling, stress management/mental health education/counseling

*In this table, our models are adjusted for age, sex, race/ethnicity, region, insurance type, whether the provider was the PCP, and whether the visit was located in a metropolitan area.

Table 5. Adjusted* Odds Ratios for Factors Associated with Ordering CT/MRI, Referrals to Physicians, and Clinician Counseling (Significant Factors in Bold)

Predictor variables	Ordering a CT/MRI	Referral to Physician	Clinician Counseling
	aOR [95 % CI]	aOR [95 % CI]	aOR [95 % CI]
Age (decades)	1.01 [0.92, 1.10]	0.99 [0.91, 1.07]	1.01 [0.94, 1.09]
Sex			
Male	1.00 [1.00, 1.00]	1.00 [1.00, 1.00]	1.00 [1.00, 1.00]
Female	0.66 [0.51, 0.87]	0.80 [0.61, 1.07]	1.15 [0.88, 1.50]
Race/ethnicity†			
White	1.00 [1.00, 1.00]	1.00 [1.00, 1.00]	1.00 [1.00, 1.00]
Black	1.20 [0.81, 1.77]	1.71 [1.24, 2.35]	1.00 [0.78, 1.37]
Hispanic	0.87 [0.61, 1.24]	0.95 [0.63, 1.43]	1.38 [0.92, 2.08]
Other	0.71 [0.51, 1.16]	0.57 [0.25, 1.26]	1.99 [1.22, 3.23]
Insurance status			
Private	1.00 [1.00, 1.00]	1.00 [1.00, 1.00]	1.00 [1.00, 1.00]
Medicare	1.37 [0.89, 2.11]	1.08 [0.65, 1.78]	0.91 [0.64, 1.31]
Medicaid	1.00 [0.65, 1.55]	1.08 [0.65, 1.78]	1.61 [1.17, 2.21]
Workers' comp	0.52 [0.20, 1.39]	1.15 [0.34, 3.83]	1.21 [0.41, 3.58]
Uninsured	0.77 [0.51, 1.16]	0.82 [0.57, 1.19]	1.21 [0.64, 1.58]
Identified PCP	0.56 [0.42, 0.74]	0.80 [0.62, 1.03]	1.93 [1.60, 2.33]
Metro area	1.26 [0.88, 1.79]	0.81 [0.52, 1.25]	1.31 [0.97, 1.76]
Region			
Northeast	1.00 [1.00, 1.00]	1.00 [1.00, 1.00]	1.00 [1.00, 1.00]
Midwest	0.88 [0.60, 1.31]	1.18 [0.75, 1.85]	0.68 [0.49, 0.96]
South	0.97 [0.70, 1.35]	1.52 [1.00, 2.33]	0.65 [0.45, 0.94]
West	0.78 [0.51, 1.20]	1.82 [1.25, 2.65]	0.74 [0.50, 1.08]
Headache chief complaint			
Acute or new onset	1.00 [1.00, 1.00]	1.00 [1.00, 1.00]	1.00 [1.00, 1.00]
Chronic routine	0.47 [0.35, 0.63]	0.59 [0.42, 0.82]	1.20 [0.94, 1.53]
Other context	0.70 [0.51, 0.96]	0.66 [0.49, 0.89]	1.30 [0.99, 1.72]
Decade	2.61 [1.65, 4.13]	1.91 [1.30, 2.80]	0.65 [0.47, 0.90]

CT computed tomography, MRI magnetic resonance imaging, NSAIDs non-steroidal anti-inflammatory drugs, APAP acetaminophen, Preventive medications propranolol, verapamil, amitriptyline, and topiramate, Lifestyle modification counseling diet and nutrition education/counseling, exercise education/counseling, stress management/mental health education/counseling

*In this table, our models are adjusted for age, sex, race/ethnicity, region, insurance type, symptom duration, whether the provider was the PCP, and whether the visit was located in a metropolitan area.

† White, black, and other patients are all non-Hispanic in origin. Hispanic origin may include patients of any race. Other race/ethnicity includes persons of Asian, Native Hawaiian, Pacific Islander, American Indian, or multiple races.

referrals to other physicians, although tests for the latter interaction were non-significant ($p=0.14$).

Stratified results comparing patients with acute headache versus chronic headache also demonstrated similar trends (Table 4). Use of CT/MRI appeared to rise more rapidly among patients with acute symptoms compared to those with chronic symptoms, although this difference did not achieve significance ($p=0.13$ for interaction). In addition, patients with chronic headache had lower adjusted odds of receiving referrals to other physicians (OR 0.59 [0.42, 0.82]) or undergoing advanced imaging (0.47 [0.35, 0.63]) compared to other presentations, although there were no significant differences over time, as trends in referrals and imaging still nearly doubled for both groups. Finally, trends in the acute/new-onset or “gold-standard” subgroup were similar to trends in the entire cohort.

Comparing visits where the clinician was identified as the PCP versus non-PCP visits also yielded similar trends (see the Online Appendix for Table A7). PCPs had greater adjusted odds of offering behavioral modification counseling compared to non-PCPs (1.93 [1.60, 2.33]). Additionally, PCPs had lower adjusted odds of ordering advanced imaging compared to non-PCPs (0.56 [0.42, 0.74]), although both subgroups saw a similar rise in use of advanced imaging.

Correlates of Use

Table 5 presents results of multivariable logistic regression models estimating the use of CT or MRI, referrals to other physicians, and counseling, with visits pooled for the entire study period. Females were less likely to undergo CT or MRI for headache, with adjusted OR of 0.66 [0.51, 0.87]. Patients in the South and West had greater odds of being referred to another physician (OR 1.52 [1.00, 2.33] and 1.82 [1.25, 2.65], respectively), and patients in the South and Midwest had lower odds of receiving counseling during headache visits (0.68 [0.49, 0.96] and 0.65 [0.45, 0.94], respectively) compared to patients in the Northeast. Insurance status generally was not related to the use of any of the services studied.

DISCUSSION

In this nationally representative study of trends over the past decade in U.S. practice patterns for headache, we observed several notable findings. First, we found significant increases in the use of advanced diagnostic imaging (CT or MRI), which are considered discordant with clinical guidelines. We also observed a rise in referrals to other physicians, also

inconsistent with practice guidelines. Third, we found a significant decline in clinician counseling on lifestyle modifications during headache visits, considered a first-line approach in the management of headache. Of note, these trends remained similar among PCPs and non-PCPs as well as patients with acute versus chronic symptoms. These findings have broad implications for the cost and quality of U.S. healthcare.

The near doubling in use of CT or MRI represents an area of particular concern, given escalating efforts to control increasing costs in the U.S. healthcare system through decreasing or eliminating the use of low-value services.¹¹ Non-PCPs were more likely to order advanced imaging, consistent with the notion that increased use of referrals is contributing to this trend. A recent report found that 62 % of CT head/brain studies are inappropriate, according to evidence-based guidelines, most frequently ordered inappropriately for chronic headache,¹⁴ and this overuse has significant consequences. Incidental findings provoke unnecessary patient anxiety, can lead to more invasive procedures, and often require follow-up testing.²⁰ Susceptible individuals carry the risk of anaphylaxis or acute kidney injury due to contrast dye, and in patients with chronic kidney disease, gadolinium contrast poses the risk of nephrogenic systemic fibrosis.^{20,21} Finally, ionizing radiation poses yet another hazard: in 2007, an estimated 4,000 additional cancers were created by the 18 million cranial CT studies performed in the U.S.²²

Our findings related to medication use are more encouraging. Unlike trends in the treatment of back pain,¹⁶ there has been no increase in the use of medications whose use is discouraged, such as opioids or barbiturates. Nonetheless, both classes of medications continue to be used frequently, and represent an opportunity for improved management in the future. We also observed a significant increase in guideline-recommended preventive therapies for migraine headache, including verapamil, amitriptyline, propranolol, and topiramate. Multiple randomized controlled trials have demonstrated that these therapies (particularly the latter three) reduce the recurrence of migraine episodes,⁹ and their use is higher particularly among patients with migraine headache, consistent with clinical guidelines.

We also find that while clinicians increasingly prescribe medications, order advanced imaging, and refer to other physicians, they are less often providing lifestyle modification counseling during headache visits. Although ambulatory visit length has slightly increased over time, primary care clinicians consistently report increasing time pressures, due to several factors: 1) a greater number of recommended treatments and preventive services; 2) more informed, assertive, and inquisitive patients, including increased patient inquiries about prescription drug advertisements; and 3) increased

documentation demands.^{23–25} This perception is bolstered by a rise in the number of clinical items addressed in each U.S. primary care visit, which has led to a marked decline in the amount of time allotted per clinical item, falling from a mean of 4.4 minutes per item in 1997 to 3.8 minutes per item in 2005.²⁶ Studies have demonstrated that increased time pressures in primary care lead to inappropriate prescribing, increased malpractice claims, and reduced patient and physician satisfaction.²⁷ Taken in this context, our findings suggest that the traditional 20-minute-visit-based care model may discourage the use of time-intensive tasks such as counseling. Further research should investigate whether increasingly hurried clinicians are less likely to counsel their patients and more likely to order costly tests.

In reviewing our stratified analyses, we found similar trends in the different subgroups, suggesting that these important potential confounders did not alter our main findings. Although the use of imaging and referrals was greater for acute headaches, the rate of change was nearly identical for both acute and chronic headaches, doubling for both. Clinician counseling also decreased similarly among patients with both acute and chronic headache. Finally, although non-PCPs more frequently ordered CT or MRI studies, the rate of change was similar for both PCPs and non-PCPs—again, with a near doubling in the two subgroups.

Our study had several limitations. First, the NAMCS and NHAMCS are cross-sectional surveys, and therefore, tracking use among individual patients is not possible. However, because the data are collected the same way each year, trends over time likely reflect real changes in practice patterns, and we have no reason to believe that the proportion of visits with indications for various diagnostic tests or treatments would have changed over time. Second, although we lacked complete data on the duration of symptoms, we present results stratified by acute versus chronic presentations, which revealed similar trends, and visits with this information available comprised over 80 % of our sample. Third, although some visits classified as guideline-discordant may, in fact, have been considered appropriate if additional clinical data (e.g., “worst headache of my life”) had been available, our focus is less on the proportion of guideline-discordant treatments and more on treatment trends over time, and we have no reason to suspect that the proportion of headaches due to serious intracranial pathology has increased over the past decade.

Despite the publication of numerous practice guidelines, clinicians are increasingly ordering advanced imaging and referring to other physicians, and are less frequently offering first-line lifestyle modification counseling to their patients. The management of headache represents an area of particular concern for our

healthcare system, and stands out as an important opportunity to improve the value of U.S. healthcare.

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Conflict of Interest: The authors each declare that they have no conflict of interest

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